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## The Impacts of Computer Technology on the Worklife of Information Workers

**Kenneth L. Kraemer and James N. Danziger**

This article assesses recent research which examines the impacts of computing on the worklife of information workers. It uses a broad analytic framework to organize discussion of research since 1985, to assess the consistency and coherence of the research, and to suggest where systematic comparative analysis is needed in the future. Research findings are summarized with regard to the impacts of computing on decision making, control, productivity, social interaction, work environment, and job enhancement. *Keywords:* social impacts of computing, information workers, decision making, control, productivity, social interaction, work environment, job enhancement.

**A**fter more than a decade of empirical studies on the social impacts of computer technology, there is now a significant body of research. At this point, it is feasible to attempt serious efforts to synthesize the research findings in order to advance toward grounded theory (Glaser & Strauss, 1967) on various issues addressing social impacts of computing. In that context, this article assesses recent research which examines the impacts of computing on the worklife of information workers. We also propose a broad analytic framework, including a set of basic concepts, which is explicit or implicit in much of the research. The framework has three general purposes: (1) it organizes our discussion of recent research; (2) it facilitates our assessment of the consistency and coherence of that research; and (3) it provides a basic schema that might encourage more systematic comparative analysis in future research.

Four essential concepts from organizational theory guide the selection of key variables for empirical research on the impacts of computer technology on information workers (Leavitt, 1983; Leavitt, Pondy, & Boje, 1989). As characterized in Figure 1, impacts are based on the interaction between people, computer technology, and the tasks performed. The figure presents a framework for a general theory of the impacts of computing on work, but is also based on the working assumption that

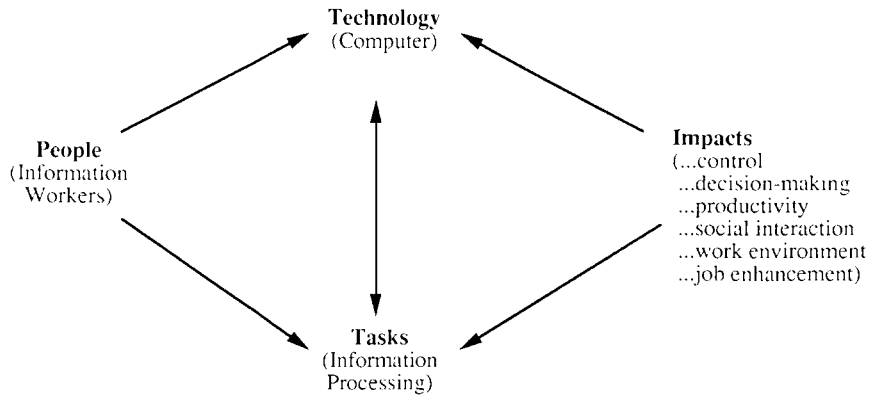


Figure 1

variations in each of the three explanatory variables, as well as the interactions between them, will affect the nature and level of impacts.

*People.* For our purposes, the relevant people are information workers in organizations. Information workers are distinguished from other workers because the primary value added by their labor results from creating, manipulating, or providing data/information/knowledge, rather than from providing services that are not information based or from processing primary commodities or intermediate goods to produce final goods. Since the impacts of computing might vary across different types of information workers, we posit three general types of information workers in large organizations: (1) *managers*, who set organizational goals and guide organizational resources to attain those goals; (2) *professionals*, who generate and apply their specialized knowledge to serve organizational functions and goal attainment; and (3) *technicians/clericals*, who provide direct services or support and who generate, store, and process information about organizational activities.<sup>1</sup>

*Tasks.* The framework assumes that computer impacts might vary systematically across different task domains. We propose a categorization of tasks which particularly highlights the array of different *information processing tasks* that are central to the activities of information workers. Three broad types of such tasks seem most common. First, *information exchange* involves the transmission of data and can be accomplished through media ranging from conversation to memoranda to reports to telecommunications. Second, *information storage and retrieval* centers in the recording of and access to organizational data and can be accomplished by activities ranging from personal memory to manual files to computerized databases. Third, *information analysis* entails the assessment of data and can be performed by modes ranging from personal thought to pencil-and-paper calculations to graphical summaries to sophisticated mathematical computations.

*Computer technology.* The concept of computer technology refers to both the particular causal agent in which the research is especially interested and also the context of technology-in-use. Computer technol-

ogy can be defined narrowly to include only the actual hardware employed to perform a basic information processing task. Or it can encompass the entire "computer package" of hardware, software, personnel, and organizational arrangements through which computing is provided to information workers (Danziger, Dutton, Kling, & Kraemer, 1982). While we believe that the appropriate conceptualization of the technology must ultimately be a set of variables capturing the computer package, a parsimonious approach seems most appropriate at this point. In studying information workers, such a taxonomy might have the greatest theoretical value if it captures the primary mode and locus of control for the provision of computing services. Thus, we distinguish three modalities of computing: (1) *centralized computing*, in which a technical line agency is generally responsible for providing computer-based services to end users and computing services are mainly in a mainframe-based environment; (2) *departmental computing*, in which hardware, software, and skilled technical personnel for computer-based services are primarily controlled by the operating unit, which organizes computing on the basis of a mainframe/minicomputer environment; and (3) *end user computing*, in which individual users or small work groups have substantial control over their own computing software, hardware, and services and the core of computing is microcomputers and associated networks.

The computing utilized by many workers in actual organizations does not correspond exactly to any of these ideal types; but the configurations of hardware, software, personnel, and policies governing computing services for each type are distinctive and actual contexts of computing that can be classified by their general correspondence to one of these three types. Implicit in this taxonomy is the assumption that different computing configurations will have differential impacts. Given the limited analyses of variations in computing in the available impacts research, this remains an empirical issue.

*Impacts.* Finally, computer impacts are those effects on worklife that are experienced by end users and other information workers due to their use of computer technology or computer-based products in their work. Among the most commonly identified impacts of computing on work are its effects on these six dimensions:

1. *decision making*—the capacity to formulate alternatives, estimate effects, and make choices;
2. *control*—the power relations between different actors;
3. *productivity*—the ratio of inputs to outputs in the production of goods and services;
4. *social interaction*—the frequency and quality of interpersonal relationships among coworkers;
5. *job enhancement*—the skill variety and job domain; and
6. *work environment*—the affective and evaluative orientations of the worker toward the setting of work.

The discussion in the next section considers findings from recent empirical research that seem relevant to each of the six types of impacts.

The selection of research includes only work published in the last five years. These were identified from a literature search of the impact keywords in three indexes: *Information Science Abstracts*, *Social Science Citations Index*, and the *ACM Guide to Computing Literature*. In addition, a few key journals (e.g., *Communications of the ACM*, *MIS Quarterly*, *Harvard Business Review*, *Public Administration Review*, *Sloan Management Review*, *Social Science Computer Review*) were searched. When the identified articles and books were examined, a large proportion were excluded from this discussion because they were predominantly theoretical, summaries of other research, minimally empirical, or did not measure specific impacts on work. The studies cited are a selective and, we believe, representative set of the more rigorous, theory-oriented empirical analyses examining the impacts of computing on information workers.

### Findings about Computer Impacts on Information Workers

#### *Decision Making*

The earliest and most enticing impact of computing for information workers has been its promise for improving decision making through more and better information, easier access to information, and better distillation of information through formal modeling, analysis, expert systems, and artificial intelligence. The early research indicated that computing improved the accuracy and availability of information, but that easier access to and effective distillation of information were elusive benefits. Recent research on the computer's impact on decision making by information workers is sparse. It indicates that the intelligent distillation of information is not yet a widespread benefit of computing, although it does provide many information workers with higher quality and more accessible information for decision and action.

Danziger and Kraemer (1986) report that computing has improved routine decision making for a substantial majority of information workers, across the full range of roles, by increasing the speed with which information can be obtained, the ease of access to information, the availability of new information, and the timeliness of the information. McGowan and Lombardo (1986) conclude that computerized decision support systems have generally facilitated decision making by public managers, especially in anticipating problems, obtaining resources, and gaining interagency cooperation. In addition, Kraemer, Dickhoven, Fallows-Tierney, and King (1987) indicate that computer-based models provide marginal but significant improvements in decision making for managers and professionals by furnishing a structure within which analysis and debate can occur, even on unstructured, highly visible, and politically charged decisions.

However, as Perolle (1988b) has noted, managerial and technical problem solving often call for broader understanding and more flexible thinking than has been embodied in even extremely "intelligent" programs. Thus, for example, Frank, Krassa, Pacek, and Radcliff (1988) in-

Table 1 Summary of Decision-Making Impacts

Study	Decision-Making Impacts
Attewell, 1987	Managers felt enhanced control because computing made available more timely and detailed information.
Aydin, 1989	Administrative concerns with efficiency and productivity subject professionals to the kind of close control originally developed to monitor in lower-skilled and lower-paid occupations.
Bjorn-Anderson, Eason & Robey, 1986	Autonomy of managers was reduced.
Danziger & Kraemer, 1987	Computing has increased the speed with which information can be obtained, the ease of access to information, the availability of new information, and the timeliness of the information for a substantial majority of information in all roles.
Frank, Krassa, Pacek, & Radcliff, 1988	Computers provide little assistance in the decision-making process that a lawyer faces in daily practice.
Irving, Higgins, & Safayeni, 1986	Computerized monitoring is associated with perceived increases in office productivity, more accurate assessment of workers' performance, and higher levels of organizational control. Workers perceive increased stress, lower levels of satisfaction, a decrease in the quality of their relationships with peers and management.
Kraemer, Dickhoven, Fallows-Tierney, & King, 1987	Computer-based models are an accepted, even indispensable feature of policy making. Some are routinely used (economic forecasting models) whereas others are used more episodically (social welfare models). The models enhance the diversity of information available, provide systematic means of reducing uncertainty, and provides answers to what-if questions.
Kraut, Dumais, & Koch, 1989	Supervisors' evaluation of service reps became more time consuming.
Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987	The greater the time spent on CADD, the more users reported formalized procedures for doing the job, more standardized operating procedures to cover situations encountered on the jobs, and a greater specification of job duties.
McGowan & Lombardo, 1986	Computer-based systems are especially helpful to middle managers for anticipating problems and obtaining resources, especially in the areas of expenditure decisions and program analysis.
Millman & Hartwick, 1987	Increased autonomy.
Perolle, 1986	"Intellectual assembly line" arrangements sometimes prove unsatisfactory for some types of staff professionals whom problem solving often calls for broader understanding and more flexible thinking than has been embodied in even extremely "intelligent" programs.

dicade that computers have not yet provided much assistance in the decision making processes of lawyers. Sproull and Kiesler (1986) report that decision making can actually be less effective with the use of electronic mail systems, which seem to increase the frequency with which participants violate the norms of socially acceptable communication.

Thus, the computer's impact on decision making by information workers is mixed. There are clear information benefits from the technology's use and there are marginal but significant improvements in decision making, even on complex issues. But the touted benefits from expert systems and artificial intelligence that would "make" decisions or even significantly aid human decision makers, remain elusive and probably will remain so for some time.

### *Control*

The impact of computing on control, or the relative distribution of power enjoyed by different information workers, remains uncertain and even controversial. This was a major point in the *SSCORE* social impacts survey articles in both 1988 and 1989 (Thompson, Sarbaugh-McCall, & Norris, 1989; Perolle, 1988b). One perspective on computing and control stresses the capacity of computing to increase the information worker's ability to influence others, to reduce the time pressures associated with the information processing aspects of work, and to increase the sense of mastery over one's work. An alternative perspective stresses the use of computing by superiors to monitor a person's work, and the tendency of computing use to increase the time pressures felt by information workers and to alienate them from work. Earlier research concluded that computing tended to increase work monitoring by superiors and to produce greater time pressure on most jobs. These impacts were identified mainly for clerical/administrative workers, although they were sometimes reported for professionals and managers.

Recent research clarifies and extends these earlier findings. First, at the conceptual level, shifts of control due to computing should distinguish those related to other *people* from those related to the *job* itself. Moreover, the control impacts of computing need not be conceptualized only as zero sum, since there need not be equivalence between beneficiaries and losers (Thompson et al., 1989). Thus, at least three aspects of the impacts of computing on control warrant consideration: (1) control of the individual's work by others, as illustrated by the closeness of supervision; (2) the individual's control over others, as illustrated by his/her capacity to alter the behavior of others; and (3) the constraints on the individual's work behavior imposed by the job itself, as illustrated by the level of time pressure on the job (Danziger & Kraemer, 1986).

Second, most information workers—regardless of type—report *no change* due to computing on control of their work by others and their control over others (Danziger & Kraemer, 1986; Millman & Hartwick, 1987). These findings might be explained by the fact that direct control is primarily associated with computerized monitoring systems, few of

which are actually implemented, and that the general capabilities for monitoring that exist in such systems are seldom used. Where monitoring systems are used, however, they are reported to provide a higher level of organizational control and greater capacity for judging performance. A particularly interesting observation from the recent studies is that work monitoring via the computer is now a reality for professionals as it has been for clerical/administrative workers (Bjorn-Anderson, Eason, & Robey, 1986; Irving, Higgins, & Safayeni, 1986).

Third, where there is an effect on control over others, managers and professionals enjoy greater increases in control attributed to computing than do clerical/administrative workers (Attewell, forthcoming; Aydin, 1989; Danziger & Kraemer, 1986; Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987; Millman & Hartwick, 1987). However, computerized systems can also make the task of control more difficult, especially for those in superordinate roles who themselves become dependent on the technology. For example, the study of supervisors and customer service representatives in a large public utility by Kraut, Dumais, and Koch (1989) found that, as a result of installing a new customer inquiry system, the supervisors' work was made both more difficult and more technology-dependent. In the past, supervisors had known the job of their subordinates because they themselves had previously been customer service representatives; however, with the introduction of the new computerized system, their knowledge was suddenly obsolete. The supervisors did not possess nor were they provided with training to develop the skills they needed to operate in the new computerized environment.

Fourth, computerization has increased information workers' sense of control over certain aspects of the job, including mastery over relevant information and improved communications. The most significant impact of computing on control of the job reported by information workers, however, is an increase in time pressures (Danziger & Kraemer, 1986; Irving et al., 1986; Jackson, 1987).

Thus, for the most part, computing has had minimal impact on control over *people* in the work situation. Where it has had an impact, it has tended to increase control by managers and professionals and to decrease the autonomy of clerical/administrative workers. Also, there is some evidence that computerized systems can make the task of supervision more difficult and technology dependent when superordinates do not understand the technological changes. In addition, computing has had a mixed impact on information workers' sense of control over their *job*, with increased time pressures being the most widespread effect.

### *Productivity*

Computers had been expected to increase worker productivity primarily through decreasing the number of individuals required to do various organizational tasks. Early studies reported little job displacement among information workers and that, when it occurred, it was primarily through attrition rather than large-scale layoffs. It seemed the same



Table 2   Summary of Productivity Impacts

Study	Productivity Impacts
Attewell, forthcoming	Information technology increased productivity about 7% (measured as employee increase necessary for current volume of work in absence of computerization).
Aydin, 1989	Greater clarity and accuracy in reports and the elimination of discrepancies between records in different departments.
Bikson, 1986	40% of work groups report substantial increase in outputs; 47% of work groups report some increase.
Danziger & Kraemer, 1986	End users attribute efficiency benefits from computer use for themselves and for their departments. The greatest benefits are attributed by street-level workers.
Danziger, 1988	Word processing and data analysis resulted in moderate increases in research productivity among most end users.
Frank, Krassa, Pacek, & Radcliff, 1988	Word processing, support in legal research and litigation, and retrieval systems have tremendously increased productivity.
Irving, Higgins, & Safayeni, 1986	Computerized monitoring was associated with perceived increases in office productivity and increased quality of work output.
Kraut, Dumais, & Koch, 1989	Frequency of work-related tasks increased by almost 50%. While having positive productivity effects on the service reps, it had negative effects on their supervisors.
Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987	Increased job satisfaction was achieved not by CADD, but by the increased productivity, creativity, quality of work, varied tasks and responsibility over work that resulted when organizations implementing CADD induced such changes.
Millman & Hartwick, 1987	Middle managers perceived that their personal effectiveness, as well as their department and organization, had improved.

number of workers were able to handle more work where the workload was increasing, and that there were productivity gains from increased quality of work. Computerization reduced errors in information handling, resulted in less rework, and allowed more jobs to be completed all at once rather than sequentially.

Recent studies indicate that the computer's effect on productivity continues to be positive. As automation has spread throughout organizations, most productivity gains for information workers continue to be marginal and incremental rather than massive and sudden. But there are increasing instances where productivity gains are very substantial. Information workers report that computerization has increased productivity at various levels in the organization: the individual, the work

group, the department, and the organization. Moreover, these perceptions appear to be shared by workers across all three general types of organizational roles, ranging from top managers to secretaries, and across a diversity of computerized systems, ranging from CADD systems to performance monitoring systems to customer inquiry systems to word processing systems.

Two broad aspects of productivity have received the most attention: the quantity of work output and the quality of work produced. Most of the recent studies agree that computerization has substantially increased the quantity of work output, although few explicitly measure the full costs of providing computing services (Attewell, forthcoming; Bjorn-Anderson et al., 1986; Danziger & Kraemer, 1986; Majchrzak et al., 1987). One study indicated that a customer inquiry system increased output by 50% in a large public utility (Kraut et al., 1989). Another (Bikson, 1986) indicated that 40% of work groups reported "substantial" increase in outputs and 47% of work groups reported "some" increase. In a third study, 76% of the middle managers reported increased productivity, although 22% indicated that their productivity had decreased (Millman & Hartwick, 1987).

The effects of computerization on the quality of work are generally positive, although the findings are considerably mixed. Some studies found that those in managerial and professional roles are more likely to report that computing has significantly improved the quality of their task performance (Danziger, 1988; Danziger & Kraemer, 1986; Millman & Hartwick, 1987). But there are also studies in which there is evidence that quality has not changed or has actually decreased. For example, managers in one study were as likely to attribute computing with decreases as with increases in the quality of their work (Irving et al., 1986). Aydin's (1989) study of a hospital indicated that a pharmacy information system resulted in greater clarity and accuracy in reports and the elimination of discrepancies between records in the hospital as a whole, but neither the nursing nor the pharmacy departments felt the system increased work quality for their department. Similarly, the utility study by Kraut, Dumais, and Koch (1989) concluded that while the quality of work was improved for service representatives, it was not improved for their supervisors.

In at least some cases, subtle or indirect effects of computing on productivity are specified. For example, a study of computerized monitoring systems (CMS) found evidence that they increased the productivity of many individual information workers and departments. However, the productivity gains seemed to occur simply because the CMS exist—not because their monitoring capabilities are used extensively. That is, the existence of CMS communicates to workers that performance is being monitored; it is the potential for monitoring, more than the actual use of the monitoring information, that has effected productivity. Some information workers resist CMS when they perceive the systems are used to increase work output without consideration for quality, reasonableness, or worker stress (Irving et al., 1986).

Perhaps the most notable recent increase in the scope of impacts from computing on information workers has been on their social interactions with each other and with computer experts. Because information workers' computer use was relatively limited until recently, earlier studies indicated that the computer's impact on social interaction was mainly on the relationships between supervisors and clerical/administrative workers and between information workers and the computer experts. Even now, most computerized systems have little or no direct effect on the social interactions of information workers. But the more extensive use of computing on many information processing tasks and the introduction of office automation and PC networks has broadened the computer's impact on social interactions. These impacts now extend to peer-to-peer relations, to most supervisor-subordinate relations, and to most computer expert-end user relations. The impacts primarily center on the interdependence and communication aspects of these relationships.

Peer-to-peer relations have been most affected by the introduction of computerized systems that cross departmental boundaries, such as office automation systems. Both interdependence and communication have been influenced. In general, the interdependence between individuals and between work groups connected by computerized systems has increased (Irving et al., 1986). These impacts are not uniform among all end users. For example, Majchrzak and her colleagues (1987) found that CADD drafters and designers within the same unit did not feel increased interdependence between their jobs as a result of the new computerized system, but they did feel increased interdependence and mutual sharing with other units. Even this case provides support for the generalization that computerization increases interdependence.

In general, communication among peers as a result of computerized systems has also been increased. For example, Sproull and Kiesler (1986) report that 60% of the messages sent via electronic mail contained information that respondents reported would not have been sent or received if there were no electronic mail (although most of it was not work related). Snizek (1987) reports that microcomputer networks facilitated communication with geographically dispersed peers. Computing does not seem to have diminished face-to-face communication. Indeed, most research indicates that people who communicate electronically or share common databases meet face-to-face as often as before the computerized system; they simply increase the total amount of communication (Aydin, 1989; Majchrzak et al., 1987). (In a contrary example, Kraut et al. [1989] report that contact among service representatives in a public utility became less frequent as a result of computerization, primarily because the pace of work quickened tremendously.)

Social interaction between superiors and subordinates has also been affected, and the type of computerized system seems to be a factor in the differential impacts. Computerized monitoring systems seem to decrease the quality of relations between peers, supervisors, and senior

Table 3 Summary of Social Interaction Impacts

Study	Social Interaction Impacts
Aydin, 1989	Information technology was not associated with decreased personal communication between departments, but it increased face-to-face communications between departments.
Bjorn-Anderson, Eason, & Robey, 1986	Managers reported increases in the more participative as well as the less participative channels and means of influence. Managers on different hierarchical levels perceive the computer-induced changes differently. Tendency toward a standardization of leadership style.
Danziger, 1988	Computing had limited, positive effects on both peer and superordinate-subordinate relations.
Irving, Higgins, & Safayeni, 1986	No change for the most part. Where there was a change, it was towards a decrease in the quality of relationships with peers, supervisors, and senior management primarily due to increased stress.
Kraut, Dumais, & Koch, 1989	Contact with work colleagues became less frequent and a less satisfying component of service reps' work.
Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987	CADD increases communication and changes communication patterns among workers. The system did not replace face-to-face communication and CADD users did not perceive their jobs to involve more reciprocal interdependence.
Millman & Hartwick, 1987	Relationships with supervisors and fellow workers were unchanged or improved. Electronic mail and teleconferencing were not found to have a significant effect on perceptions of supervision or relationships with fellow workers.
Sproull & Kiesler, 1987	Electronic mail reduced social context cues. It provided information that was relatively self-absorbed, undifferentiated by status, uninhibited, and provided new information. 60% of the messages contained information that respondents reported they would not have gotten (or sent) if there were no electronic mail. The majority of new information arrived via access to people not personally known.
Snizek, 1987	Microcomputer networks facilitated communication with geographically dispersed peers and reduced interactions with local staff.

management (Irving et al., 1986). In contrast, office automation systems can increase the quality of social interactions. While electronic mail and teleconferencing systems often have little effect on information workers' perceptions of their supervisors or peers, those impacts that have been identified are generally positive, in the sense that relationships with fellow workers increase and supervision decreases (Millman & Hartwick, 1987). Moreover, electronic mail systems have been found

to reduce social context cues such as status differences, resulting in more uninhibited communications (Sproull & Kiesler, 1986).

Despite the earlier prescriptive emphasis on the importance of the socio-technical interface (STI) between end users and computer experts, few recent studies of information workers analyze these relations. Danziger and Kraemer (1986) indicate that end users who interact with more responsive computer experts—those responsive to end users' needs to gain competence and experience, to receive assistance with computing problems, and to coordinate their own computing activities with the larger systems and databases of the organization—are characterized by increased utilization, greater job performance benefits, more favorable work environment effects, and fewer problems with computing than end users who operate in a context lacking responsive computer specialists. Interestingly, they did not study interdependence or communication between end users and computer experts.

#### *Work Environment*

It has been widely assumed that computing can have quite significant effects on the individual's work environment. One dimension of these effects is job stress and work pressure. Given the speed and tirelessness with which computing systems can operate, the early expectation was that computing would generally increase the work rate for information workers as it has on many production line jobs. Recent empirical research reinforces earlier studies in concluding that computing does increase the time pressure and the stress experienced by information workers. While a few studies find that automated systems decrease time pressure (Kraut et al., 1989), most research indicates that workers more frequently report increased pressure and stress from computing (Danziger & Kraemer, 1986; Irving et al., 1986; Majchrzak et al., 1987; Millman & Hartwick, 1987; Perolle, 1987).

In some cases, the computerized systems create "intellectual assembly lines" where the automated system determines (and substantially increases) the rate at which new units of work are provided and must be processed (Perolle, 1986). As noted above, there are other cases where information workers feel more job pressure because their work is being more fully and precisely monitored, creating formal or informal norms of productivity to which they respond (Irving et al., 1986).

The effects of computing have usually been very positive in a second dimension of the quality of work environment which is job satisfaction. Although early studies presumed that computing effects such as increased time pressure and "deskilling" (see the section on job enhancement) would reduce workers' satisfaction with their jobs, recent empirical research indicates that the effects are more complex. In fact, the most common conclusion is that computing has increased information workers' satisfaction and interest in their work. The cause of this impact varies. For some, the improvements in their capacity to access and manipulate information give them a greater sense of empowerment and control over their work (Danziger & Kraemer, 1986; Millman & Hart-

Table 4 Quality of Work Environment Impacts

Study	Quality of Work Environment Impacts
Attewell, 1987	Computing has made managers' work-life more difficult, especially due to greater dependency on departments outside their jurisdiction.
Gatticker, Gutek, & Berger, 1988	Use of equipment makes work more interesting.
Irving, Higgins, & Safayeni, 1986	Workers perceive increased stress, lower levels of satisfaction, and a decrease in the quality of their relationships with peers and management as a consequence of computerized monitoring.
Kraut, Dumais, & Koch, 1989	Service representatives liked their jobs significantly less. Overall interest level and enjoyment of the job had deteriorated. Contact with work colleagues become less frequent and less satisfying component of service reps' work. Less job pressure after the introduction of the billing system. Even though performing more tasks per day, service reps believed that their overall workload had been reduced, that they could work slower, and that they were less likely to face time pressures to complete work.
Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987	Stress increases due to the computer-paced nature of the CADD system. CADD users indicated that they derived significantly more "identity" in completing an entire product when they used CADD than when they were using manual drafting techniques.
Millman & Hartwick, 1987	Jobs became more enriching and satisfying.
Perolle, 1987	Computer does not schedule a pause between incoming calls for telephone operators; in some locations, calls have tripled to between 80 and 120 calls per operator per hour.

wick, 1987). Other information workers perceive that they have increased status in the eyes of coworkers or clients because of their mastery of a sophisticated technology (Moore, 1987). And some studies find that workers enjoy using computers, which are described as a fun and interesting tool (Gattiker, Gutek, & Berger, 1988).

Not all studies conclude that computing has a positive effect on job satisfaction. Overall, the impacts of computing on job satisfaction seem particularly contingent upon the kinds of changes in the workplace associated with the implementation of the technology. In some cases, no direct relationship between computing and satisfaction is evident (Majchrzak et al., 1987). And in some cases, especially for information workers who reported increased job pressure or decreased sense of mastery over their work, appraisal of the effects of the technology on job satisfaction has been negative (Irving et al., 1986; Kraut et al., 1989).

#### *Job Enhancement*

We suggest a conceptual distinction between work environment effects and job enhancement, although the two involve somewhat similar ele-

ments. The quality of the work environment focuses on broad affective and evaluative responses to work, such as level of satisfaction and time pressure. In contrast, job enhancement emphasizes job content, particularly the variety of different tasks and the level of skills for a given job.

One of the most heated and ideological early debates among scholars considering the impacts of computing on work was about the job enhancement issue of "deskilling" (Perolle, 1988b). At the macro level, the question has been whether increasing the use of computer technology reduces the average skill levels of all workers in the economy (Attewell, 1987). At the micro level, the corresponding question has been whether computing reduces or expands the task variety and skills associated with particular work roles. The early research found some evidence of deskilling among those in highly routinized information jobs, such as clerical work.

Although there are some contradictory findings (Kraut et al., 1989), most of the recent empirical research does not support the hypothesis that computing deskills information workers. Especially for those types of information workers whose work intrinsically involves diverse skills and task variety, computing has generally enhanced workers' perceptions of their job domain. This has been the conclusion in studies of managers (Attewell, forthcoming; Bjorn-Anderson et al., 1986; Millman & Hartwick, 1987), of service professionals such as doctors and librarians (Perolle, 1986; Hahn, Gray, & Langston, 1987; Moore, 1987) and of analytic professionals such as engineers and academic researchers (Danziger, 1988; Majchrzak et al., 1987).

For most information workers, computing expands both the number of different tasks that are part of their job repertoire and the array of skills that they can bring to bear on those tasks. For example, in a study of fourteen diverse organizations, middle managers reported that office automation had enhanced their work. More than 70% reported that office automation had increased the variety of skills they needed on the job, and less than 2% indicated that the diversity of skills required for their work had decreased (Millman & Hartwick, 1987). Similarly, less than 15% of the librarians in another study attributed a reduction in skill mix to the use of computing in their work (Hahn et al., 1987).

### **Toward More Comparative Analyses of Computing Impacts**

Seven general, metatheoretical observations emerge from our assessment of the recent empirical studies of the impacts of computing on information workers.

1. Recent research reveals an increased awareness of the need for greater analytic precision in the study of the social impacts of computing. As one might expect with the expansion of positivist research methodologies, the recent studies surveyed in this article do attempt to build on the cumulative base of other studies. This, and the use of empirical data and more rigorous methods of analysis, result in greater consistency in the use of key concepts, more convergence in the selection

Table 5 Summary of Job Enhancement Impacts

Study	Job Enhancement Impacts
Attewell, 1987	Analyses of Bureau of Labor Statistics do not support the deskilling hypothesis, but show an upgrading of the insurance work force, for the 1966–1980 period.
Attewell, forthcoming	Most managers experienced no change in the skills demanded; upgrading more frequent than deskilling.
Bjorn-Anderson, Eason, & Robey, 1986	While the computer system helped them develop a more enriched view of their task, they felt that the system was constraining them more through standardization and monitoring of when and how to conduct their task. Managers positively evaluated increases in enriching factors (providing satisfaction) and structure factors (providing routine and workload).
Kraut, Dumais, & Koch, 1989	The record system deskilled the jobs, both by making them less complex, interesting, and challenging, and by making service reps' previous skills and training less relevant to a changed work process.
Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987	CADD demanded certain skills previously considered not nearly as important, and included among the most important, communication, coordination, and creativity (American Institute for Design and Drafting Survey). CADD research suggest that overall skill requirements of most jobs with CADD are increasing.
Millman & Hartwick, 1987	Work became more demanding, requiring additional individual skills and accuracy. Those who used the mainframe were more likely to report that automation had increased the demands for skill and accuracy on the job.
Perolle, 1986, 1988a	Technology tended to eliminate the engineering support staff and to incorporate test and drawing functions into the design and engineer's work.  Deskilling claims are best supported for the lower levels of mental work—skilled blue-collar, clerical, and technician jobs. Even among clerical workers, both skilling and deskilling effects have been reported for managers, professionals and skilled technician, skill enhancement.

of major variables, and more sensitivity to contingent effects. This survey also indicates, however, the great distance between recent research and the existence of a systematic, comparative framework to guide most studies of the impacts of computing on information workers. No shared set of analytic categories is employed in the research and there is not even an accepted base of empirical findings. These shortcomings are even more appropriate if the research focus broadens to all types of workers.

2. In terms of the four broad elements of people, technology, tasks and impacts, there is greatest agreement on the types of *work impacts* that



are worthy of study. Most studies do examine a subset of the six impact areas discussed in this article. The effects of computing on social interaction and job enhancement among information workers have been the most common subjects of the impacts studies, and it is generally concluded that these effects have been minimal and/or positive (rather than negative). The relevant studies usually report significant productivity gains for information workers, although the added costs of computing are seldom considered explicitly. Increased stress and time pressure attributed to computing tend to result in negative assessments regarding impacts on the quality of work environment. While there is considerable speculative writing on the intriguing questions regarding computing impacts on control and decision making, these are areas characterized by the most sketchy and ambiguous empirical findings.

3. To a large extent, all of the impacts reported here have been measured subjectively, usually by the self-reports of actors. In some cases, these self-reports have been confirmed by probing interviews conducted with a small sample of the respondents (Attewell, forthcoming; Danziger & Kraemer, 1986). While actors' evaluations are quite appropriate for most work impacts, especially ones such as job enhancement and social interactions, it would be desirable to have additional objective measures, especially of such impacts as productivity and decision making.

4. It is quite striking that there are not yet clear taxonomic categories with which to conduct research and compare across studies on such concepts as people, technology, and tasks. With respect to people, there is no precise delineation of *information workers*, and there is certainly no accepted classification of types of such workers (for an interesting attempt, see Weber, 1988). Roughly the same proportion of studies examine information workers from each of the three types we suggest in Table 6: managers, staff professionals, or technicians/clericals. Although there are exceptions (Bjorn-Anderson et al., 1986; Danziger & Kraemer, 1986; Reese, 1988), most studies do not make explicit comparisons across worker types. Consequently, the research does not yet provide much systematic evidence or broader generalizations regarding whether computing has distinctive impacts on different types of information workers.

5. It is perhaps most surprising that there is such limited attention in the empirical research to specifying the nature of the computing technology being studied. At most, studies tend to provide a brief characterization of whether the computing environment is mainframe-based or PC-based. There is minimal effort to establish a richer analytic description of the computing technology-in-use. Given the evolution of the technology and of the relationships between users and providers, we have suggested in Table 6 that one might at least distinguish three broad styles of technological provision: centralized provision, department-based computing, and end user computing.

For most of the studies we assessed, the information about computing provision was so sketchy that it was not possible to categorize the

Table 6 Summary of research characteristics

Study	Study characteristics			Task				Technology			
	N	Method	Roles	Info exchange	Info storage retrieval	Info analysis	Unclear	Central-ized	Depart-mental	End user	Unclear
Anderson, Jay, Schweer, & Anderson, 1986	270	Survey	Professionals	•	•			•			
Attewell, 1987		Case study	Technical / clerical & professionals				•				•
Atwell, forthcoming	200	Survey & interviews	Managers		•	•					•
Aydin, 1989	140	Survey & interviews	Professionals	•	•						•
Bikson, 1986	530	Survey	Managers, professionals, & technical/ clerical	•	•	•		•	•	•	
Bjorn-Anderson, Eason & Robey, 1986	87	Case study, survey & interviews	Managers	•	•	•		•		•	
Danziger, 1988	42	Survey & interviews	Professionals	•		•				•	
Danziger & Kraemer, 1986	2,500	Survey & interviews	Managers, professionals, & technical/ clerical		•	•				•	
Gattiker, Gutek, & Berger, 1988	81	Survey	Technical/ clerical & managers					•		•	
Irving, Higgins, & Safayeni, 1986	144	Survey	Technical/ clerical			•					•
Kraemer, Dickhoven, Fallows-Tierney, & King, 1987		Case study	Managers & professionals	•			•				•
Kraut, Dumais, & Koch, 1989	745	Survey	Technical/ clerical & managers	•	•						•
Liker, Roitman, & Roskies, 1987	60	Interviews	Managers, professionals & technical/ clerical	•			•				
Majchrzak, Chang, Barfield, Eberts, & Salvendy, 1987	88	Survey	Professionals								
McGowan & Lombardo, 1986	Not specified	Survey	Managers and professionals	•						•	+
Millman & Hartwick, 1987	75	Survey	Managers				•			•	
Morrell & Fleischer, 1988	92	Survey	Managers	•	•						
Perolle, 1988 a, b		Survey	Professionals		•	•			•		
Raphaeli & Sutton, 1986	109	Survey	Clerical		•				•		
Snizek, 1987	54	Interviews	Professionals	•		•				•	
Sproull & Kiesler, 1986	96	Survey	Technical/ clerical, professionals & Managers	•					•		

Table 6 continued

Impacts					
Decision making	Job enhancement	Control	Social interaction	Productivity	Quality of work environment
-	+		-		
	-				
+			+		
			+	+	
			+		
	+ / -	-	+ / -		
	o / +	+			-
+	+	+ / -		+	+ / -
			+ / -		
		-	-	+	-
	-		-	+ / -	-
	+		+	+	
	+	-	No effect		No effect
				+	
	+	+	+ / -	+	
+	+	+			
	+			+	
	+		+ / -	+ / -	
			+ / -		

studies within this minimal framework, or even to determine whether the computing was predominantly mainframe, PC-based, or a mix of the two. Ideally, the context of computing should include measures of the computer hardware and software, the computer competency of end users, and the nature of the socio-technical interface between end users and the providers of computing services. It seems to us that the development and use of categories defining the context of computing are the most important task for enhancing comparative research on the impacts of computing on information workers.

6. Similarly, there is a variety of tasks that an information worker might undertake with the assistance of computing, yet most studies give little or no attention to this variation. The studies tend to focus on one or more tasks that seem especially relevant, interesting, or measurable for the particular information workers in the study. There is minimal effort to locate those tasks in a broader conceptual framework, whether for the purposes of comparative analysis within the study's sample, for within role comparisons across studies, or for the development of broader generalizations. For reasons of parsimony, we suggest three broad information processing tasks for information workers in Table 6: information exchange, information storage and retrieval, and information analysis. In the studies of computing impacts in the table, all three types of tasks are well represented, although very few studies examine all three or attempt to analyze whether there are significant differences in impacts across these types of information processing tasks.

7. It also seems important that future research conceptualizes and analyzes different "task-technology" mixes. The value of separate treatment of task and technology seems evident, since theory, research, and experience all suggest that computing impacts vary on each of these two dimensions. But there is also reason to believe that distinctive task-technology mixes are notable for both practical and empirical reasons, even though there has been minimal theoretical development of this concept. Most real-world information systems can be described as a combination of a particular task and a specific technology. For example, customer information systems such as inquiry or reservations systems are oriented toward information storage and retrieval; but they could be based on vastly different technology platforms with differential impacts on particular work tasks and on the fuller array of work impacts surveyed above. For example, storage and retrieval systems on mainframes might vary systematically from PC networks on response times, vulnerability to disruption, accessibility to data files, and worker communication over long distances. Such differences could affect the end users' productivity, work environment, or other work impacts. These are questions which cannot be effectively addressed by assessing current empirical research. We believe that the task-technology mix is a potentially conceptual basis for developing theory which is both elegant and parsimonious.

In sum, there is a steady increase in the number of sound and thoughtful empirical studies of the impacts of computing on information work-

ers. This research enhances our insights about the array of computing effects. While these studies provide a valuable basis for grounded theory, since they constitute the empirical building blocks for developing broader generalizations, they also reveal the deficiencies in a research area that is still emergent. To this point, they do not provide compelling verification that there are general impacts which obtain across all information workers regardless of task and technological system. Rather, most of the studies posit that impacts are contingent (Attewell, forthcoming; Danziger & Kraemer, 1986), although no attempt to specify the crucial contingencies has been embraced by the research community. Indeed, there is an absence of consensus within the research community on the basic conceptual elements which should structure the research.

The need remains to establish taxonomic categories for information workers, for the tasks that they perform, and particularly for the specific technology so that empirical studies have greater comparability and can produce more systematic and cumulative findings. The meta-analyses and literature surveys like those conducted in this annual issue of *SSCORE* serve an important function in increasing the coherence in the research. The production of high-quality, comparative empirical studies which attempt to attain consensus on concepts and findings is the most essential component in advancing our knowledge regarding the impacts of computing on information workers and on all the social impacts of information technology.

## Notes

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1. This is a broad-based category which ranges from departmental bookkeepers and business officers to building and health inspectors to secretaries and counter clerks. These are information workers whose occupational group lacks the characteristics normally associated with being a "profession."

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